Use of Modeling to Facilitate Interstate Collaboration On the Lower Susquehanna River

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In 2002, the Susquehanna River Basin Commission (the Commission) convened the Conowingo Pond Workgroup (the Workgroup) to recommend a management plan for the Conowingo pond, a 14 mile-long interstate water body created by construction of the Conowingo dam on the Lower Susquehanna River. The pond, which straddles the Pennsylvania-Maryland border, serves multiple uses. During recent low flow conditions on the Susquehanna River, the pond demonstrated an inability to meet all existing uses, and the Commission had determined that a more comprehensive management scheme was needed to avoid conflicts. As a regional, interstate agency with basinwide water allocation and consumptive use regulatory authority, the Commission was uniquely qualified to initiate and lead the Workgroup effort.

The Workgroup undertook a four-year planning effort to evaluate operational alternatives for the pond and to recommend to the Commission a management plan that best meets the water use needs identified by the Workgroup. Additionally, the Workgroup was tasked with identifying management actions that the Commission should incorporate into its regulatory and water resource management programs. The Workgroup completed their report in March 2006, which served as the basis for the Conowingo Pond Management Plan adopted by the Commission.

The composition of the Workgroup was intended to represent the interests of key stakeholders in the operation and use of the pond. Participation remained open to any interested party throughout the process, but invitations to participate were extended directly to targeted representatives from federal and state agencies, local jurisdictions, operators of the lower Susquehanna hydroelectric facilities and Peach Bottom Atomic Power Station, local water utilities, and the Commission. Importantly, all targeted parties were active in Workgroup activities. The Workgroup met several times a year and provided direction, oversight, input, and review for the planning effort and its results. Other interested parties that did not directly participate were kept apprised of the Workgroup's progress.

As noted above, the Conowingo pond was created by the construction of the Conowingo dam in 1928 to provide hydroelectric power generation for the Conowingo Hydroelectric Station. Operation of the dam by Exelon Generation, Inc. (Exelon) is subject to the requirements of the Federal Energy Regulatory Commission (FERC). These requirements include provisions related to minimum flow releases and maintenance of recreational pond levels. Current minimum flows, which vary by season, were established to provide protection for fishery resources, with highest minimum flows

required during the anadromous fish migratory period in spring, and intermittent flows permitted only during the winter, when fish populations are limited. The minimum flows resulted from a multi-party settlement reached in 1988 after a prolonged, contentious legal battle during the last FERC relicensing of Conowingo dam.

By virtue of the pond, a stable source of water storage for other purposes was also provided. The Muddy Run Pumped Storage Hydroelectric Facility, built in 1968, cycles water back and forth from the pond for additional power generation. The water in the Conowingo pond is also used for public water supply by the City of Baltimore and Chester Water Authority, and for industrial cooling by the Peach Bottom Atomic Power Station. Finally, the pond provides a valuable recreational, fish, and wildlife resource.

Under normal and slightly below average flow conditions, there is generally ample water in the lower Susquehanna River to maintain hydroelectric operations; support water supply demands; sustain recreational, fish, and wildlife activities; and meet required flows to downstream river reaches and the upper Chesapeake Bay. However, during more severe low flow conditions, the available water becomes insufficient to meet all prescribed uses and required needs. During such periods, as Exelon operates the Conowingo dam in accordance with its FERC license requirements, storage levels in the Conowingo and Muddy Run facilities begin to decline. Declining pond levels pose a threat to Peach Bottom's cooling water intake, Muddy Run's intake, the use of recreation facilities, shore habitat, and maintenance of downstream flows. In response to declining pond levels and worsening conditions, FERC has authorized Exelon on five occasions to temporarily include water leaking through closed wicket gates toward meeting the dam's daily minimum flow release requirement. The 1988 settlement agreement specifically excludes that water from the minimum release calculation, but FERC has overridden the exclusion during the four events.

The first year of Workgroup deliberations was spent sharing information and developing working relationships among stakeholders with different – and often conflicting – objectives. In order to investigate and recommend a management plan for the Conowingo pond, it was important that the members of the Workgroup provide insights to the diversified interests related to the pond's resources. These interests include hydroelectric power generation, public water supply, water use upstream of the Conowingo pond, minimum flow release requirements, minimum dissolved oxygen requirements, summertime minimum recreational pond levels, multipurpose benefits, anadromous fish migration, upstream reservoir storage, environmental resources, and cooperative management. The Workgroup collectively assessed the interests and identified problems and conflicts that needed to be addressed. They were:

1. Maintaining FERC mandated minimum flow releases from the Conowingo pond can lead to disruption in power production, water supply withdrawal limitations and diminished recreational opportunities during significant low flow events, and depletes storage that might otherwise be available for release during low flow events of extended duration.

2. Temporary waivers to allow inclusion of gate leakage towards meeting minimum flow releases have been authorized by FERC four times (1999, 2001, 2002, and 2005) during recent droughts, but only under emergency or near-emergency conditions when time is critical and serious impacts are developing with no projected improvement.

3. Increased salinity levels in the Susquehanna River downstream of the Conowingo dam during low flow conditions can negatively impact the water supply for the city of Havre de Grace, Maryland, located at the mouth of the river.

4. Consumptive water use in the Susquehanna River Basin, from and upstream of the Conowingo pond, is increasing and could eventually impact negatively on the pond and those who rely on its water.

5. Commission-owned water supply storage at two federal reservoirs in the upper basin is managed under operating rules that were developed for water supply users elsewhere in the Susquehanna River Basin. Releases from these reservoirs are not mandated by FERC license requirements and may not provide optimum and timely benefits to the Conowingo pond during low flow conditions.

6. Increasing public water supply needs for Baltimore City, Harford County, Chester Water Authority, and the areas of Pennsylvania and Maryland surrounding the Conowingo pond are expected to lead to requests for greater withdrawals from the pond or the Susquehanna River just upstream.

7. Increased consumptive water use needs (i.e., cooling water for a new thermoelectric power plant) could require additional withdrawals from the pond.

A valuable tool developed and used during the planning study was the Commission's OASIS computer model. The OASIS software was chosen based on its successful application in the Delaware River basin. SRBC had used other software to model certain extents of the basin, but they were not specifically designed for water resource analysis and lacked the flexibility and multi-objective capability of OASIS. The services of the creators of OASIS, HydroLogics, Inc., were also retained to develop the model and provide guidance in the modeling and CADRe process.

The daily flow model incorporated more than 70 years of hydrologic record throughout the basin and was used to measure the impacts of various operation parameters on the pond and flow conditions downstream. In addition to hydrologic flow records and basinwide estimates of existing and future consumptive water uses, the model included representations of the operation of large public water supply withdrawals, power plants, and reservoirs in the Susquehanna River Basin. The stakeholders were as directly involved in development of the model as possible, from providing operating data

to reviewing and verifying modeled operations. Due to this direct involvement, there was good confidence by the Workgroup that the model accurately reflected current operating conditions.

Using the model, baseline conditions (i.e., existing operations) were established and a series of 32 initial alternatives was evaluated. Key parameters identified for the evaluation included minimum downstream flow requirements, credit for leakage of water at the dam, water supply withdrawals under normal and low flow conditions, consumptive water use in the basin above the Conowingo pond, and the use of Commission-owned storage at two upstream reservoirs to augment low flows. The workgroup participated in computer-aided negotiations (CAN) to perform efficient evaluations of the long-term implications of changes in operating policies and facility configurations. Comparative output displays of Conowingo pond levels and dam releases allowed the Workgroup to evaluate the numerous operation alternatives and make recommendations for the management of the pond. The iterative process embodied in the CAN sessions served to inform the Workgroup members about the pros and cons of many alternatives on a consistent and balanced basis. Over time, the CAN sessions were also valuable in further building the credibility of the model with Workgroup members.

After review of the initial 32 alternatives, the Workgroup developed 6 final alternatives for closer analysis leading up to the selection of a preferred operating plan. The alternatives differed mainly in operating rules for release requirements from the Conowingo dam during times of low flow. Parameters such as demand for water supply, water withdrawal operations, and upstream consumptive use were kept constant to allow for direct comparison between alternatives. A thorough evaluation of the six preferred alternatives using the OASIS model led to the selected plan, which contains favorable elements of several of the final alternatives.

Based on results of the modeled alternatives, the Workgroup identified the leakage and the minimum release requirement as the most critical parameters in managing low flows and enabling the Conowingo pond to remain viable during droughts. While water conservation measures and the release of augmenting flow from upstream reservoir storage were deemed reasonable measures worthy of consideration, the supplemental volume of water they provide was found to be small relative to the daily fluctuations of the pond, and simply did not offer substantial drought mitigation. Therefore, the selected Conowingo Pond Management Plan was based on establishing a formal protocol to implement a credit for leakage, and to specifying the hydrologic conditions under which the credit is warranted.

The selected plan includes initiation of an automatic credit for leakage of up to 800 cubic feet per second (cfs), when the flow conditions at the upstream Marietta gage decline to a flow of 1,000 cfs greater than the seasonal flow thresholds (“Q-FERC”) established by FERC for that gage. The Marietta flow threshold is 5,000 cfs between June 1 and September 14, and decreases to 3,500 cfs on September 15 through the end of November.

Modeled simulation runs of operating the resource under the recommended guideline produced favorable results. They demonstrated the most favorable balance for preserving adequate levels in the pond, ensuring reliable multipurpose use of the pond, and meeting the requirements for the quantity of water released to the downstream reaches of the Susquehanna River and the Chesapeake Bay. To further avoid potential negative impacts, the Workgroup conditioned its recommendation with restrictions that prohibit Exelon from automatically taking a credit for leakage during the spring fish spawning and migration season (April 1 – June 30) and limit the credit to only the portion of the 800 cfs that is absolutely necessary to maintain viable pond levels.

Arrival at the consensus recommendation is attributable entirely to the lessons learned from using the model. The exercise provided new insights that helped to dispel preconceived ideas of how best to solve the low flow problems of the Conowingo Pond. For example, as mentioned above, use of upstream reservoir storage did not address the problem as well as some Workgroup members anticipated. Likewise, most members were surprised to find that the system – including downstream releases – as a whole functioned better under scenarios implementing a credit for leakage earlier in a drought than later.

Implementation of the selected plan will require that Exelon successfully petition FERC for an amendment to the existing license to include the altered disposition of the gate leakage during drought conditions. The thorough planning effort of the Workgroup over the past four years and formal support of the proposed license amendment by the agencies involved are expected to be positive input to the FERC review process. The Workgroup will convene annually to review project operations, assess the potential for hydrologic conditions to develop into drought, and conduct a drought operations exercise. The hydrologic model used to develop the management plan is to be kept up to date by the Commission for the Workgroup's use, and will accurately reflect current water withdrawals in both the pond and the Susquehanna River Basin, as well as current policies and operation protocols. The Workgroup will also be responsible for reviewing and updating, as necessary, the selected management plan on a periodic basis not to exceed five years. Workgroup members, although no more bound to continue participation as they were during the initial process, seem committed to extending their roles through the follow-up activities. The need for the Conowingo facility to undergo relicensing by FERC in 2014 is no doubt an incentive; much of the work conducted thus far by the Workgroup will be revisited in that process and play a role in the development of new license conditions. The relicensing process will also likely cause additional stakeholders to become interested in Conowingo operations. Any with a direct stake in the operation of Conowingo Dam during low flows will be invited to join the Workgroup.

The planning study also identified three related actions beneficial to managing the Conowingo pond that the Commission supports including in its regulatory and water resource management programs. They are:

1. Consideration of the impacts of increasing consumptive water use in the basin on the Conowingo pond and determination of what measures, if any, are necessary to mitigate the impacts.

2. Investigation of the water supply storage owned by the Commission at the federal Cowanesque and Curwensville Lakes projects for alternative operational strategies to provide more effective low flow augmentation, including benefits to the Conowingo pond and instream resources below the dam.

3. Incorporation of key management principles and tools described in this report, including the use of the annually updated hydrologic model, into the Commission's regulatory and water resource management programs.

The Commission demonstrated its support for implementing the above recommendations by formally adopting the Conowingo Pond Management Plan in March, 2006.

The Workgroup's report, with its documented and thorough analysis, provides valuable information for the Commission, public water suppliers, power companies, and environmental resource agencies in making regulatory and management decisions involving the resources of the lower Susquehanna River. The Commission's OASIS model developed during the Workgroup's deliberations will continue to serve this same community in the years ahead.

Given the potential for increased water use and future withdrawals in the upstream basin and from the Conowingo pond, the adoption of the Conowingo Pond Management Plan and related actions is intended to ensure sustainable operations and a reliable water source for all needs, from public water supply and power generation to recreation and aquatic habitat, for many years to come. However, the resource is still not without limitations, and it is just one part of a much larger system. There exist many potential conflicts and future unknowns, ranging from large diversions to impacts of climate change, which cannot necessarily be accommodated under the recommended management plan. The recommended related actions by SRBC and others will serve to acknowledge the limitations of the resource and be important in planning for the ongoing management of the Susquehanna River basin.